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RESEARCH ARTICLE

Taxonomic study of *Spilomena* (Hymenoptera: Crabronidae) with a new species and five new records from China

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ABSTRACT. A new species, *Spilomena capatrata* Bashir & Ma, sp. nov. is described from Palearctic and Oriental China. Additionally, eleven species are reported, of which five are new records from China: *S. beata* Blüthgen, *S. hainesi* N. Smith, *S. menkei* R. Bohart, *S. punctatissima* Blüthgen, and *S. valkeilai* Vikberg. A key to Chinese species of *Spilomena* Shuckard is also provided.

KEY WORDS. Palearctic, Pemphredonina, Pemphredonini, Oriental, taxonomy.

INTRODUCTION

Spilomena Shuckard, 1838 belongs to the subtribe Spilomenina, tribe Pemphredonini, and subfamily Pemphredoninae (Pulawski 2020a). This genus is distributed in all zoogeographical realms and comprises 90 described species. Most species are known from the Palearctic region (22 species), followed by the Neotropical (17), Nearctic (16), Australian (13), Afrotropical (11), and Oriental regions (10 species); one species is recorded from both the Palearctic and Oriental regions (Blüthgen 1953, Tsuneki 1971, Bohart and Menke 1976, Antropov 1991, 1992, Bohart and Smith 1995, Simon 1995, Vikberg 2000, Rajan et al. 2018, Pulawski 2020b). In China, six species have been recorded, of which one occurs in Palearctic China, four are distributed in Oriental China, and one is known from both Palearctic and Oriental China (Li and He 1998a, 1998b, Ma et al. 2018). Four new species were relatively recently described: *S. ferrugina* Li & He, 1999 from Guizhou, *S. zhejiangana* Li & He, 1998 from Zhejiang, and *S. clypei* Li & He, 1998 and *S. rhytithoracica* Li & He, 1998 from Yunnan (Li and He 1998a, 1998b). *Spilomena clyperugata* Ma & Li, 2018 and the unknown female of *S. zhejiangana* Li & He, 1998 were described in the most recent contribution (Ma et al. 2018).

The diagnostic characteristics that differentiate *Spilomena* from other genera in Pemphredonini are as follows: mandible bidentate apically; malar space short to moderate; labrum truncate apically; scapal basin hardly indicated; lower frons with short longitudinal ridge; clypeus not covered with dense setae; eyes broadly separated, inner margins parallel or slightly converging above; occipital carina lacking; transverse carina present on pronotum; notaulus weakly impressed; episternal sulcus displaced forward and arising beneath pronotal lobe; without definite omaulus; scrobal sulcus absent; hypersternaulus sulcus very weak, horizontal, sometimes indicated; in females, rake absent on foretarsus; lack of spines on posterior margin of hind tibia; stigma large; R1 extending up to end of marginal cell; two submarginal cells present; hind wing media diverging at cu-a, not separated from cu; petiole lacking or short, not longer than broad; pygidial plate lacking or narrow (Bohart and Menke 1976).

Herein, we describe and illustrate a new *Spilomena* species from Yunnan Province and Ningxia Hui Autonomous Region of China. Additionally, five species are recorded from China for the first time. Figures and a key to the Chinese species of the genus are given.

MATERIAL AND METHODS

Types and other specimens examined in this study are deposited in Yunnan Agricultural University, Kunming, Yunnan, China (YNAU) and Zhejiang University, Hangzhou, Zhejiang, China (ZJU).

The specimens were observed and described using an Olympus stereomicroscope (SZ Series, Japan) with an ocular micrometer. Photographs were taken with a camera attached to a VHX-5000 digital microscope and were edited using Adobe Photoshop® 8.0. Morphological terminology follows those of Bohart and Menke (1976) and Harris (1979). Measurements and ratio were acquired using an ocular scale on Olympus stereomi-

croscope SZX2-TR30 (Tokyo, Japan) at 2X and 5X magnification, respectively. The abbreviations used are as follows: AOD: distance from inner eye margin to antennal socket (in frontal view); EL: eye length (in lateral view, maximum); EW: eye width (in lateral view, maximum); EWd: eye width (in frontal view, maximum); G: gaster segment; HLD: head length in dorsal view (distance from frons to occipital margin in the middle); HLF: head length in frontal view (distance from vertex to the clypeal margin); HW: head width (in dorsal view); HWmax: head width (in dorsal view, maximum); HWmin: head width (in dorsal view, minimum); IAD: distance between antennal sockets (in frontal view); IODc: distance between inner eye margin to the base of clypeus (in frontal view); IODmin: minimum distance between inner eye margins (in frontal view); IODv: distance between inner eye margin to the base of vertex (in dorsal view); LS: length of scape; LFI: length of flagellomere I; LFII: length of flagellomere II; LP: length of pedicel; OCD: ocello-occipital distance (distance between posterior margin of hind ocellus and occipital margin, in dorsal view); OOD: ocellocular distance (distance between outer margin of hind ocellus and nearest inner orbit); POD: postocellar distance (distance between inner margins of hind ocelli); S: sternum; T: tergum; TW: gena width (in lateral view, maximum); WAS: width of antennal socket (in frontal view); WFI: width of flagellomere I; WFII: width of flagellomere II.

TAXONOMY

Key to Chinese species of *Spilomena* Shuckard

1 Female (tergum 6, frons and/or clypeus without white or yellow marks) (Figs 1, 6)..... 2
1′ Male (tergum 7, frons and/or clypeus with white or yellow marks) (Turillazzi et al. 2014: fig. 5)..... 12
2 Anterior groove of scutellum not crenulate (just like a simple line)..... 3
2′ Anterior groove of scutellum crenulate (Fig. 3)..... 6
3 Metanotum distinctly coriaceous; pygidial area long (longer than wide), with lateral carinae (Ma et al. 2018: fig. 60F); palpi fulvous; clypeus dark brown..... *S. menkei* Bohart, 1995
3′ Metanotum slightly coriaceous (Fig. 4); pygidial area inconspicuous or short (wider than long), without lateral carinae; palpi dark brown; clypeus black..... 4
4. S2 without groove; midtibial spur relatively short (less than midocellus diameter); propodeal enclosure carina complete; vertex behind ocelli coarsely and transversely coriaceous, with dense and coarse punctures; outer tooth of mandible acute, inner tooth blunt..... *S. beata* Blüthgen, 1953
4′. S2 with narrow transverse groove (Fig. 8); midtibial spur long (longer than or equal to midocellus diameter); propodeal enclosure carina incomplete or lacking; vertex behind ocelli distinctly coriaceous mixed with sparse and fine punctures; both teeth of mandible blunt..... 5
5. Pygidial area inconspicuous; S2 deeply impressed, divided into two parts (Fig. 8); metapleuron with sparse and fine punctures; mesopleuron dull, with distinctly longitudinal microsculptures and dense, short longitudinal rugae posteriorly; mesoscutum without rugae on posterior area; head from above with temples distinctly convergent posteriorly (Bohart and Smith 1995: fig. 14)..... *S. clypei* Li & He, 1998
5′. Pygidial area short (wider than long); S2 shallowly impressed, inconspicuously divided; metapleuron smooth; mesopleuron shiny with sparse and fine punctures and dense, long longitudinal rugae on lower area; mesoscutum with sparse, sturdy and long longitudinal rugae posteriorly; head from above with temples roundly convergent posteriorly ..... *S. punctatissima* Blüthgen, 1953
6. Propodeal enclosure poorly defined with carina developed or inconspicuous (Fig. 4)..... 7
6′. Propodeal enclosure well-defined with carina, sturdy and slender, incomplete or complete..... 9
7. Lower propodeal side reticulate (Fig. 5); pygidial area inconspicuous; mesoscutum posteriorly without rugae (Fig. 3)..... *S. capatrata* Bashir & Ma, sp. nov.
7′. Lower propodeal side with transverse short rugae; pygidial area narrow, dull and long (longer than wide), with distinct lateral carinae; mesoscutum posteriorly with short longitudinal rugae (Vikberg 2000: figs 1, 2) 8
8. Propodeum with conspicuous rugae posteriorly (Ma et al. 2018: fig. 60D); clypeus with dense and slender longitudinal rugae on basal and medial area (Ma et al. 2018: fig. 60A); ocellar area and upper frons with sparse punctures; T1 with narrow deep groove and a broad shallow depression basally; metapleuron dull ..... *S. clyperugata* Ma & Li, 2018
8′. Propodeum reticulate posteriorly; clypeus without rugae; ocellar area and upper frons with dense punctures; T1 with broad median groove, and sturdy, irregular, longitudinal rugae basally; metapleuron shiny..... *S. rhytithoracica* Li & He, 1998
9. Propodeal enclosure triangular; propodeal side posterior with several sturdy and short longitudinal rugae; gaster fulvous to dark brown; lower frons dark brown..... *S. ferrugina* Li & He, 1999
9′. Propodeal enclosure U-shaped (Ma et al. 2018: fig. 60D); propodeal side posterior with irregular reticulation or oblique longitudinal rugae; gaster black; lower frons black 10
10. Propodeal enclosure carina conspicuous and complete; mesoscutum distinctly coriaceous; head from above with temples rarely convergent posteriorly (Bohart and Smith 1995: fig. 15); gena distinctly coriaceous, with coarse punctures; palpi, scape, and pedicel dark brown ..... *S. valkeilai* Vikberg, 2000
10′. Propodeal enclosure carina slender and incomplete; mesoscutum coarsely coriaceous; head from above with temples distinctly or roundly convergent posteriorly (Bohart and Smith 1995: figs 9, 14); gena slightly coriaceous, with fine punctures or not punctate; palpi, scape, and pedicel fulvous, yellowish or ivory white..... 11
11. Posterior propodeal side with irregular reticulation; propodeum with irregular reticulation; metapleuron with sparse and fine punctures; mesoscutum with sparse or dense, slender and short longitudinal rugae posteriorly

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Figures 1–8. *Spilomena capatrata* Bashir & Ma, sp. nov., female: (1) head, frontal view; (2) head, dorsal view; (3) mesoscutum and metanotum, dorsal view; (4) propodeum, dorsal view; (5) thorax, lateral view; (6) metasoma, lateral view; (7) metasomal T1, dorsal view; (8) metasomal T1, ventral view. Scale bar: 1.0 mm.

(Vikberg 2000: figs 1, 2); mandibular teeth blunt ....*S. zhejiangana* Li & He, 1998

11′. Posterior propodeal side with slender and oblique longitudinal or in some cases inconspicuous rugae; propodeum with sturdy, longitudinal rugae; metapleuron smooth; mesoscutum without rugae posteriorly (Fig. 3); outer tooth of mandible acute, inner tooth blunt..... ..... *S. formosana* (Tsuneki, 1971)

12. Scutellum anterior groove not crenulate (just like a simple line); posterior area of scutum without rugae (Fig. 3); head from above with temples distinctly convergent posteriorly (Bohart and Smith 1995: fig. 14) .... *S. formosana* (Tsuneki, 1971)

12′. Scutellum anterior groove crenulate (Fig. 3); posterior area of scutum with sparse or dense, slender and short longitudinal rugae (Vikberg 2000: figs 1, 2); head from above with temples roundly convergent posteriorly (Fig. 1)..... 13

13. S2 deeply impressed, divided into two distinct parts (Fig. 8); posterior propodeal side with irregular reticulation; metapleuron with fine and sparse punctures; body black; clypeus black; lower frons with small ivory white spot apicolaterally (diameter less than 0.5 mm) ....*S. zhejiangana* Li & He, 1998

13′. S2 shallowly impressed, poorly divided; posterior propodeal side with longitudinal rugae; metapleuron smooth or with strong, transverse and long carina; body dark brown; clypeus ivory white; lower frons with large ivory spot apicolaterally (diameter more than 0.5 mm) 14

14. Metapleuron with strong, transverse and long carina; metanotum slightly coriaceous, without striations laterally; upper frons with sparse and coarse punctures; lower and median frons with conspicuous frontal carina, extending up to clypeal line; yellowish setae on clypeus and mandible; tegula fulvous ..... *S. ferrugina* Li & He, 1999

14′. Metapleuron smooth; metanotum distinctly coriaceous, with longitudinal striations laterally; upper frons not punctate; lower and median frons without median carina; silvery setae on clypeus and mandible; tegula reddish-brown to dark brown .....*S. hainesi* N. Smith, 1995

Spilomena capatrata Bashir & Ma, sp. nov.

Figs 1–9

http://zoobank.org/3853C507-1397-4B3D-A0ED-5DE0440C1462

Type material. Holotype: female, China: Yunnan, Luchun County, Fenshuiling, 22°59′N, 102°27′E, 1900–1980 m, 25.VII.2003, coll. Peng Wang (YNAU). Paratypes: 3 females, China: Ningxia, Liupan Mountain, Hongxia Forest farm, 35°46′N, 106°11′E, 1.VII.2008, 1900 m, #201004812, 201004805, 201004839, coll. Jingxian Liu (YNAU); 1 female, China: Ningxia, Jingyuan County, Liupan Mountain, Heshanpu Forest farm, 35°40′N, 106°14′E, 26.VI.2008, #201004920, coll. Jingxian Liu (YNAU).

Diagnosis. This species differs from *Spilomena beata* Blüthgen, 1953 by the following features: free margin of clypeus deeply emarginated mesally; vertex behind ocelli with sparse and fine punctures; anterior groove of scutellum crenulate; posterior area of mesopleuron with long, longitudinal rugae; metapleuron shiny and smooth; propodeal enclosure carina absent; upper lateral surface of propodeum with dense, slender and oblique longitudinal rugae, lower area reticulate; midtibial spur long (greater than or equal to midocellus diameter); G3–6 dull, slightly coriaceous; basal third of S2 with a much narrowed and transverse groove, deeply impressed, divided into two distinct parts; pygidial area inconspicuous. *Spilomena beata* has the following characters: free margin of clypeus nearly truncate, slightly emarginate at middle; vertex behind ocelli with dense and coarse punctures; anterior groove of scutellum without crenulation (just like a simple line); posterior area of mesopleuron with short, longitudinal rugae; metapleuron dull, with dense and coarse punctures; propodeal enclosure with complete slender carina; anterior and medial lateral surface of propodeum with dense and slender longitudinal striations, and irregular reticulation posteriorly; midtibial spur relatively short (less than midocellus diameter); G4–6 coarsely coriaceous; S2 without groove, shallowly impressed; pygidial area narrow and short (wider than long).

Description. Female (Figs 1–9): Body length 2.4–2.9 mm.

Colour pattern. Body black except: mandible reddish-brown on apex, palpi and forewing veins fulvous, tegula dark brown, fore- and midlegs mostly dark brown except tibia and tarsus fulvous to reddish-brown, hind tibia reddish brown except basal third and tarsus fulvous, setae on clypeus and mandible silvery.

Head. Mandible bidentate apically, teeth acute, outer tooth larger than inner; setae on mandible sparse, long on apex (Fig. 1); labrum with two finger-like tubercles apically; clypeus shiny mesally, strongly convex, with dense and slender longitudinal rugae; free margin of clypeus slightly prominent, emarginate on middle (Fig. 1); setae on clypeus scattered, long apically; lower and median frons dull, with a sturdy frontal carina, extending up to clypeal line, coarsely coriaceous (Fig. 1); upper frons dull, coarsely coriaceous, with sparse and coarse punctures; ocellar area flat, with sparse and coarse punctures, coarsely coriaceous (Fig. 2); vertex behind ocelli dull, distinctly coriaceous mixed with sparse and fine punctures (Fig. 2); gena dull, coarsely coriaceous, with sparse and fine punctures; head from above with temples roundly convergent posteriorly; occipital carina absent (Fig. 2). Ratio of HW : HLD : HLF = 46 : 20 : 40; HWmax : HWmin = 46 : 31; EWd : EW : TW : EL = 9 : 12 : 13 : 28; AOD : WAS : IAD = 8 : 3 : 8; POD : OOD : OCD : IODc : IODv : IODmin = 5 : 11 : 7 : 30 : 31 : 30; LS : LP : LFI : WFI : LFII : WFII = 18 : 6 : 3.5 : 3 : 3 : 3.

Mesosoma. Mesoscutum mat, distinctly coriaceous, with dense and coarse punctures (Fig. 3); mesoscutellum dull, slightly coriaceous, with coarse and dense punctures; anterior groove of mesoscutellum crenulate (Fig. 3); metanotum slightly coriaceous, with sparse and fine punctures; mesopleuron dull, coarsely coriaceous, with sturdy, dense and long longitudinal

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Figures 9–14. Specimens in lateral view: (9) *Spilomena capatrata* Bashir & Ma, sp. nov., female; (10) *Spilomena beata* Blüthgen, 1953, female; (11) *Spilomena hainesi* N. Smith, 1995, male; (12) *Spilomena menkei* Bohart, 1995, female; (13) *Spilomena punctatissima* Blüthgen, 1953, female; (14) *Spilomena valkeilai* Vikberg, 2000, female. Scale bar: 1.0 mm.

rugae posteriorly (Fig. 5); metapleuron shiny and smooth; propodeal enclosure U-shaped, without propodeal carina, extensively areolate-rugose and rugulose, with two longitudinal irregular ridges anteromesally (Fig. 4); posterior lateral and medial surface of propodeum with irregular and dense rugae, posterior area with short median longitudinal rugae and several slender, transverse rugae; propodeal side with dense, slender and oblique longitudinal rugae dorsoposterioly, lower area with dense and slender reticulation (Fig. 5).

Legs. Midtibial spur long (greater than or equal to midocellus diameter), outer surface of hind tibia without spines.

Metasoma. Petiole inconspicuous (Fig. 7); S1 basally with 2–3 strong keels (Fig. 8); G1 and G2 shiny and not punctate, 3–6 dull, slightly coriaceous, with sparse and fine punctures (Fig. 6); S2 divided into two distinct parts (Fig. 8) and basal third with a very narrow and transverse groove, deeply impressed; pygidial area inconspicuous.

Male. Unknown.

Distribution. China (Yunnan, Ningxia).

Etymology. The specific epithet, *capatrata*, is derived from the Latin words *cap-* (= head) and *atrata* (= black), referring to the totally black head.

Spilomena beata Blüthgen, 1953

Fig. 10

Specimen examined. 1 female, China: Hebei, Xiaowutai Mountain, Jinhekou, 39°53'N, 114°58'E, 23.VIII.2006, #200707354, coll. Min Shi (YNAU).

Distribution. China (Hebei), France, Switzerland, Germany, Italy, Finland, England, Sweden, Austria, Belgium, Poland, Great Britain, Spain, Andorra, Bulgaria, Czech Republic, Belarus, Netherlands, Luxemburg, Denmark, Croatia, Western Slovakia, Slovenia, Portugal, Ireland, Kazakhstan, Russia, Ukraine (Pulawski 2020b).

Spilomena hainesi N. Smith, 1995

Fig. 11

Specimens examined. 1 male, China: Yunnan, Tengchong, Houqiao, 25°19'N, 98°16'E, 1.VI.2009, #201005320, coll. Jiangli Tan (YNAU); 1 male, China: Ningxia, Delongsi, Liupan Mountain, Fengtai Forest farm, 35°39'N, 106°13'E, 27–28.VI.2008, #201005832, coll. Jingxian Liu (ZJU).

Distribution. China (Yunnan, Ningxia), USA: California (Pulawski 2020b).

Spilomena menkei Bohart, 1995

Fig. 12

Specimen examined. 1 female, China: Yunnan, Dehong, Yingjiang, Tongbiguan, 24°42'N, 97°55'E, 19.V.2009, #201005253, coll. Manman Wang (YNAU).

Distribution. China (Yunnan), USA: Utah (Pulawski 2020b).

Spilomena punctatissima Blüthgen, 1953

Fig. 13

Specimen examined. 1 female, China: Inner Mongolia, Zhengxiangbaiqi, 42°17'N, 115°08'E, 14.VIII.1999, #200010485, coll. Yuanchao Guo (YNAU).

Distribution. China (Inner Mongolia), Italy, Germany, Poland, Austria, Greece, Croatia, Bulgaria, Yugoslavia, Slovenia, Turkey (Pulawski 2020b).

Spilomena valkeilai Vikberg, 2000

Fig. 14

Specimen examined. 1 female, China: Xinjiang, Tuomuer, 41°42'N, 80°43'E, 21.VII.1977, 2600 m, coll. Yinheng Han (YNAU).

Distribution. China (Xinjiang), Finland, Sweden, Norway (Pulawski 2020b).

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